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| Title | Effect of medical institution change on gestational duration after the Great East Japan Earthquake: The Fukushima Health Management Survey |
| Author(s) | Suzuki, Kohta; Goto, Aya; Fujimori, Keiya |
| Citation | The journal of obstetrics and gynaecology research. 42(12): 1704-1711 |
| Issue Date | 2016-12 |
| URL | http://ir.fmu.ac.jp/dspace/handle/123456789/1590 |
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| DOI | 10.1111/jog.13102 |
| Text Version | author |

Effect of medical institution change on gestational duration after the Great East Japan Earthquake: The Fukushima Health Management Survey

Kohta Suzuki^{1,2}, Aya Goto^{2,3}, Keiya Fujimori^{2,4} for the Pregnancy and Birth Survey Group of the Fukushima Health Management Survey

1 Department of Health Sciences, Interdisciplinary Graduate School of Medicine and Engineering, University of Yamanashi, 1110 Shimokato, Chuo, Yamanashi 409-3898, Japan

2 Radiation Medical Science Center for the Fukushima Health Management Survey, 1 Hikariga-oka, Fukushima, Fukushima 960-1295, Japan

3 Department of Obstetrics and Gynecology, School of Medicine, Fukushima Medical University, 1 Hikariga-oka, Fukushima, Fukushima 960-1295, Japan

4 Department of Public Health, School of Medicine, Fukushima Medical University, 1 Hikariga-oka, Fukushima, Fukushima 960-1295, Japan

Running Title: Huge earthquake and gestational duration

Address correspondence and reprint requests to:

Dr. Kohta Suzuki

Department of Health Sciences, Interdisciplinary Graduate School of Medicine and Engineering, University of Yamanashi

1110 Shimokato, Chuo, Yamanashi 409-3898, Japan

Tel.: +81-55-273-9566; Fax: +81-55-273-7882; E-mail: kohtas@yamanashi.ac.jp

Effect of medical institution change on gestational duration after the Great East Japan Earthquake: The Fukushima Health Management Survey

Abstract

Aim

To examine the association between medical institution change for perinatal care and gestational duration after the Great East Japan Earthquake using data from the Fukushima Health Management Survey.

Methods

The data of pregnant women who experienced the earthquake in Fukushima prefecture and participated in a pregnancy and birth survey as part of the Fukushima Health Management Survey was analyzed. The primary and secondary outcomes of this study were gestational duration and preterm birth, respectively. The main study factor was prenatal checkup institution (only one institution, changed institution for self-referral, changed institution for medical indication, and went to parents' home for childbirth). The self-referral was considered as indicative of relocation after the disaster. Multiple linear and logistic regression analyses were conducted to examine the effect of earthquake on each outcome.

Results

A total of 5,593 (60.2%) participants experienced the earthquake between the 4th and 37th weeks of their gestational period. After controlling for variables, pregnant women who changed their perinatal checkup institution for medical indication were significantly associated with shorter gestational duration ($\beta = -10.6$, $p < 0.001$) and preterm birth (Adjusted odds ratio (aOR): 8.5, 95% confidence interval (CI): 5.8–12.5) compared with women who visited only one institution. The self-referral however did not significantly associate with the outcomes.

Conclusions

It was suggested that the effect on gestational duration of the Great East Japan Earthquake and the subsequent Fukushima Daiichi nuclear disaster through prenatal checkup status was not significant.

Key words:

gestational duration, Great East Japan Earthquake, prenatal checkup, preterm birth

Introduction

It has been suggested that psychological distress during pregnancy may increase the risk of preterm birth¹. Because a natural disaster might act as a major stressor for pregnant women, the effect of a natural disaster, such as a great earthquake, has been previously suggested. For example, in Chile, the rate of preterm births, especially in girls, was increased among women who experienced the great earthquake in 2005 during pregnancy². In addition, Oyarzo et al. reported that pregnant women who experienced the earthquake in Chile in 2010 during early pregnancy were more likely to have preterm premature membrane rupture and to deliver babies before full term³. These articles suggested that maternal distress regarding the earthquake might be associated with gestational duration^{2,3}. On the other hand, Harville et al. conducted systematic review which suggested that natural disaster might affect only fetal growth and not gestational duration⁴. In Japan, there are few articles examining the association between natural disaster and perinatal outcomes including preterm birth.

On March 11, 2011, a huge earthquake occurred in East Japan called the Great East Japan Earthquake. Subsequently, a massive tsunami struck the area, and millions of people were affected. This earthquake was determined to be the most severe natural disaster in Japan in recorded history⁵. Recently, we examined effects of the Great East Japan Earthquake on perinatal outcomes including gestational duration using vital statistics of Japan. As a result, no apparent negative effect of the earthquake on gestational duration was observed⁶. However, particularly in the coastal area of Fukushima prefecture, the Fukushima Daiichi nuclear disaster occurred just after the earthquake. Therefore, many pregnant women evacuated and were forced to change medical institutions for prenatal checkup. These situations may have exposed them to stress. Although the previous study examined the effect of the earthquake itself, the effect of the subsequent situation in Fukushima prefecture on perinatal outcomes was not examined. Thus, Fukushima prefecture and Fukushima Medical University carried

out the pregnancy and birth survey as part of the Fukushima Health Management Survey⁷. This survey was questionnaire-based to describe the health conditions and support health management for pregnant women in Fukushima prefecture⁸.

This study aimed to examine the association between medical institution change and gestational duration after the Great East Japan Earthquake using pregnancy and birth survey data.

Materials and Methods

The pregnancy and birth survey

The survey population comprised women who received maternal and child health handbooks from municipal officers in Fukushima prefecture between August 1, 2010, and July 31, 2011, and women who had handbooks issued in other prefectures but received prenatal care or delivered babies in Fukushima prefecture after the disaster. The objective was to reach women who were pregnant at the time of the disaster. This survey was approved by the ethics committee of Fukushima Medical University, which is guided by local policy, national law, and the World Medical Association Declaration of Helsinki (approval #13047). Questionnaires, which can be seen on our website⁹, have been mailed out since January 18, 2012. A total of 16,001 questionnaires were distributed. Details of this survey have been described in previous articles⁸.

Study population

Of this survey population, pregnant women who experienced the earthquake were categorized according to their gestational period as of March 11, 2011, as follows: 4–11, 12–19, 20–27, and 28–36 weeks.

Data collection

General demographic and perinatal outcome data, including residential area, maternal age, parity, gestational age at delivery, birth weight, and delivery mode, were collected by questionnaire. Regarding the residential area, Iwaki city and Soso region were categorized as the coastal area. Maternal age was categorized as follows: <20, 20–24, 25–29, 30–34, and 35≤ years. In addition, the questionnaire asked their prenatal checkup status, including timing (on schedule or unscheduled) and perinatal checkup institution (only one institution, changed institution for self-referral, changed institution for medical indication, and went to parents' home for childbirth). The self-referral was considered as indicative of relocation after the disaster. Supporting the assumption, our previous study on maternal mental health reported that the self-referral was distinctly frequent in the coastal region where the disaster damage was most severe¹⁰. Moreover, in Japan, some perinatal women return to their parents' homes to obtain perinatal support from their parents, which is called a “Satogaeri” delivery.

Statistical analysis

The primary and secondary outcomes of this study were gestational duration (days) and preterm birth (gestational weeks < 37), respectively. The main study factor was prenatal checkup institution.

First, potential factors associated with institutional prenatal checkup status were compared with each category. Percentages of each gestational week category, rate of on-schedule prenatal checkups, percentages of each delivery mode, percentages of each maternal age category at delivery, rate of coastal residence, rate of male births, rate of first births, mean gestational duration (days), and mean maternal age at delivery were compared between each category of prenatal checkup institutional status. Chi-square test and analysis of

variance were conducted for categorical and continuous variables, respectively.

Next, multiple linear regression analysis and logistic regression analysis were conducted to examine the effect of earthquake on gestational duration and preterm birth, respectively, after controlling for confounding factors. In addition, based on the multiple linear regression analysis, adjusted mean gestational duration was calculated by the least-squares method. These multiple regression analyses used only the data without missing. Thus, the total numbers of women entered into the multivariate analysis (Table 2, Table 3 and Table 4) differs from the numbers in Table 1.

For sensitivity analysis, a multiple linear regression model which excluded cesarean section cases was used to control the effect of artificial preterm delivery.

All analyses were conducted using SAS version 9.3 (SAS Institute, Inc., Cary, NC, USA).

Results

Study population (Table 1)

The number of responses as of March 31, 2013, excluding 29 outside Fukushima, was 9,298 (58.2%). Of these, 5,593 (60.2%) participants experienced the earthquake during their gestational period between the 4th and 37th weeks. The characteristics of the study population are described in Table 1. Data of 5256 participants without missing were entered into subsequent analysis.

Multiple linear regression models for gestational duration (Table 2)

Pregnant women who changed their perinatal checkup institution for medical indication were significantly associated with shorter gestational duration ($\beta = -10.56$, $p < 0.001$) compared with women who visited only one institution. In addition, cesarean section ($\beta = -7.49$, $p < 0.001$ vs. normal vaginal delivery), male infants ($\beta = -0.99$, $p < 0.001$), and

second or more infants ($\beta = -1.59$, $p < 0.001$) were significantly associated with shorter gestational duration. On the other hand, instrumental vaginal delivery was associated with significantly longer gestational duration ($\beta = 1.75$, $p < 0.001$) compared with normal vaginal delivery. Based on this regression model, the adjusted gestational duration of women who changed their perinatal checkup institution for medical indication (264.3 days) was significantly shorter than for women who visited only one institution (274.9 days, $p < 0.001$ Table 3). The self-referral however did not show significant association. After excluding cesarean section cases, adjusted gestational duration of women who changed their perinatal checkup institution for medical indication (267.6 days) was significantly shorter than for women who visited only one institution (276.4 days, $p < 0.001$).

Logistic regression models for preterm birth (Table 4)

After controlling for variables as well as the multiple linear regression model, women who changed their perinatal checkup institution for medical indication were likely to give birth to preterm birth infants compared with women who visited only one institution (Adjusted odds ratio (aOR): 8.5, 95% confidence interval (CI): 5.8–12.5). The likelihood of preterm birth for the self-referral was not significant. In addition, cesarean section was associated with 3.2 times higher risk of preterm birth compared with vaginal delivery (aOR: 3.2, 95% CI: 2.4–4.3). On the other hand, female infants were significantly associated with preterm birth (aOR: 0.7, 95% CI: 0.5–0.9).

Discussion

The data from the pregnancy and birth survey suggested that there was no significant association between medical institution change for self-referral and gestational duration and preterm birth after the Great East Japan Earthquake, although institution change for medical indication and cesarean section were significantly associated with gestational duration and

preterm birth. Unscheduled prenatal checkup and the checkup with a different institution for self-referral were not significantly associated with gestational duration or preterm birth. These results suggested that the negative effect of the earthquake and subsequent Fukushima Daiichi nuclear disaster on gestational duration might be small.

Risk factors for preterm birth—especially idiopathic preterm birth—including severe maternal hypertension, abruptio placentae, and intrauterine growth restriction¹¹, have been suggested as reasons for prenatal checkup institution changes. Thus, the change of institution for medical indication, particularly to tertiary medical institutions, might be associated with shortened gestational duration and preterm birth. In addition, our results were consistent with previous reports describing the association between cesarean section and preterm birth^{12–14}. Our sensitivity analysis using a multiple linear regression model excluding cesarean section cases showed similar results as found in our main analysis. Therefore, because there were no significant associations between institution change for self-referral and gestational duration or preterm birth in main and sensitivity analyses, it might be difficult to consider institution change for self-referral as a risk factor for shortened gestational duration.

Moreover, regarding the effect of great earthquakes on gestational duration, our results were consistent with the systematic review which was carried out by Harville et al. but not with the Chilean studies^{2,3}. This discrepancy in the results might be caused by differences in geographical factors and medical support systems after natural disasters in each country.

This study has certain limitations. First, because the survey response rate was relatively low (58.2%), it might be difficult to generalize the results. Second, there might be inaccurate data, particularly in medical information like gestational duration, because of the questionnaire-based survey. In addition, prenatal checkup status as an explanatory variable might be biased, because this information was requested after delivery. However, because these biases might be non-differential, it was suggested that their effect could be small in our

relatively large study. Moreover, medical information, such as gestational duration and birth weight, was considered to be almost accurate because these were transcribed from maternal and child handbooks, which were recorded by gynecologists and midwives. Third, although it might be important to compare the effect of this kind of change in institution on gestational duration before and after the earthquake, it was impossible to conduct this analysis because we did not have pre-earthquake data. Fourth, because there was no information about the diseases and complications including psychiatric disorders which lead to change the medical institution, it was also impossible to show the detailed reasons and to examine the effect of psychiatric stresses on gestational duration. However, because our other study group described that there was no significant effect of the earthquake on perinatal outcomes including gestational period among the women who were pregnant at the time of earthquake⁶, it might be assumed that the influence of psychiatric stresses caused by the earthquake was relatively small. Moreover, in this analysis, residential area and gestational period as of March 11, 2011, might be proxy indicators of the difference in psychiatric stresses in women. For example, the effect of the disaster in coastal areas was larger than its effect in other areas. In fact, Goto et al. described the regional variation in frequency of mothers who screened positive for depressive symptoms¹⁰. However, the effect of psychiatric stress might be relatively small because, in our results, there was no significant effect of these variables on gestational duration. Fifth, because there was no information about maternal smoking during pregnancy in the survey, it was impossible to include maternal smoking status during pregnancy in the final models. Furthermore, adjusted R-squared was relatively low (0.143). However, because a recent Japanese study suggested that maternal smoking during pregnancy was not an independent risk factor for preterm birth¹⁵, the effect of this limitation might be small.

Despite these limitations, this study provided some important findings indicating that

the negative effect on gestational duration of the earthquake and subsequent nuclear disaster, which was mediated by prenatal checkup status, might be limited. However, our results might describe the effect of the earthquake on mothers and their children only in a short period. It is necessary to follow them up and provide adequate support.

In conclusion, our study results suggest that the effect of the Great East Japan Earthquake and subsequent Fukushima Daiichi nuclear disaster on gestational duration through prenatal checkup status was not significant.

Acknowledgement

Members of the Pregnancy and Birth Survey Group of the Fukushima Health Management Survey include: Akira Ohtsuru, Misao Ota, Seiji Yasumura, Shun Yasuda and Yasuhisa Nomura from Fukushima Medical University; Kenichi Hata from Fukushima Society of Obstetrics and Gynecology; and Akihito Nakai from Nippon Medical School Tama Nagayama Hospital.

This survey was supported in part by the national “Health Fund for Children and Adults Affected by the Nuclear Incident.”

The findings and conclusions of this article are solely the responsibility of the authors and do not represent the official views of the Fukushima Prefecture government.

Disclosure

None of the authors have financial or other conflicts of interest to disclose.

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Table 1 Participant characteristics by prenatal checkup institution categories

| Variables | Number of participants | Only one institution | Changed institution for self-referral | Went to parents' home for childbirth | Changed institution for medical indication | p-value [†] |
|---|------------------------|----------------------|---------------------------------------|--------------------------------------|--|----------------------|
| Gestational period as of March 11, 2011 | | | | | | <0.001 |
| 4–11 weeks | 1392 | 1055 | 275 | 7 | 55 | |
| (%) | | 25.8 | 21.9 | 12.5 | 27.4 | |
| 12–19 weeks | 1400 | 1033 | 321 | 7 | 39 | |
| (%) | | 25.3 | 25.6 | 12.5 | 19.4 | |
| 20–27 weeks | 1441 | 1060 | 319 | 14 | 48 | |
| (%) | | 26.0 | 25.5 | 25.0 | 23.9 | |
| 28–36 weeks | 1360 | 935 | 338 | 28 | 59 | |
| (%) | | 22.9 | 27.0 | 50.0 | 29.4 | |
| Prenatal checkup schedule | | | | | | <0.001 |
| On schedule | 4285 | 3340 | 780 | 32 | 133 | |
| (%) | | 81.9 | 62.5 | 57.1 | 66.5 | |
| Unscheduled | 1295 | 736 | 468 | 24 | 67 | |
| (%) | | 18.1 | 37.5 | 42.9 | 33.5 | |
| Mode of delivery | | | | | | <0.001 |
| Normal vaginal delivery | 3840 | 2796 | 903 | 37 | 104 | |
| (%) | | 68.8 | 72.4 | 67.3 | 52.3 | |
| Instrumental vaginal delivery | 590 | 458 | 116 | 3 | 13 | |
| (%) | | 11.3 | 9.3 | 5.5 | 6.5 | |
| Cesarean section | 1136 | 811 | 228 | 15 | 82 | |
| (%) | | 20.0 | 18.3 | 27.3 | 41.2 | |
| Maternal age at delivery | | | | | | 0.005 |
| <20 years | 60 | 42 | 16 | 0 | 2 | |
| (%) | | 1.0 | 1.3 | 0.0 | 1.0 | |
| 20–24 years | 705 | 546 | 115 | 7 | 37 | |
| (%) | | 13.4 | 9.2 | 12.5 | 18.4 | |
| 25–29 years | 1745 | 1255 | 413 | 19 | 58 | |
| (%) | | 30.7 | 33.0 | 33.9 | 28.9 | |
| 30–34 years | 1951 | 1409 | 464 | 21 | 57 | |
| (%) | | 34.5 | 37.0 | 37.5 | 28.4 | |
| 35≤ years | 1132 | 831 | 245 | 9 | 47 | |
| (%) | | 20.4 | 19.6 | 16.1 | 23.4 | |
| Residential area | | | | | | <0.001 |
| Coastal area | 1516 | 751 | 694 | 23 | 48 | |
| (%) | | 18.4 | 55.9 | 41.1 | 23.9 | |
| Other area | 4062 | 3329 | 547 | 33 | 153 | |
| (%) | | 81.6 | 44.1 | 58.9 | 76.1 | |
| Infant sex | | | | | | 0.4 |
| Male | 2861 | 2067 | 655 | 27 | 112 | |
| (%) | | 50.8 | 52.4 | 48.2 | 55.7 | |
| Female | 2715 | 2003 | 594 | 29 | 89 | |
| (%) | | 49.2 | 47.6 | 51.8 | 44.3 | |
| Parity | | | | | | 0.3 |
| First birth | 1438 | 1044 | 336 | 15 | 43 | |
| (%) | | 26.8 | 28.4 | 28.8 | 22.4 | |
| Second or more | 3885 | 2851 | 848 | 37 | 149 | |
| (%) | | 73.2 | 71.6 | 71.2 | 77.6 | |
| Mean gestational duration (day) | | 275.8 | 275.6 | 276.1 | 262.4 | <0.001 |
| (Standard deviation) | | 9.8 | 10.2 | 9.2 | 21.8 | |
| Mean maternal age at delivery (year) | | 30.1 | 30.4 | 30.0 | 30.0 | 0.5 |
| (Standard deviation) | | 5.0 | 4.8 | 4.5 | 5.5 | |

[†]Chi-square test and analysis of variance were conducted for categorical and continuous variables, respectively.

Table 2 Multiple linear regression model for gestational duration (day) after the Great East Japan Earthquake (n = 5,256)

| | beta | Standard error | t-value | p-value [†] |
|--|--------|----------------|---------|----------------------|
| Intercept | 277.01 | 0.60 | 462.9 | <0.001 |
| Institution of prenatal checkup | | | | <0.001 |
| Only one institution | | | | |
| Changed institution for personal reason | -0.29 | 0.36 | -0.8 | 0.4 |
| Went to parents' home for childbirth | 1.34 | 1.39 | 1.0 | 0.3 |
| Changed institution for medical indication | -10.56 | 0.74 | -14.3 | <0.001 |
| Gestational period as of March 11, 2011 | | | | 0.2 |
| 4–11 weeks | | | | |
| 12–19 weeks | 0.49 | 0.38 | 1.3 | 0.2 |
| 20–27 weeks | -0.24 | 0.38 | -0.6 | 0.5 |
| 28–36 weeks | 0.26 | 0.39 | 0.7 | 0.5 |
| Prenatal checkup schedule | | | | 0.5 |
| On schedule | | | | |
| Unscheduled | -0.22 | 0.34 | -0.7 | |
| Mode of delivery | | | | <0.001 |
| Normal vaginal delivery | | | | |
| Instrumental vaginal delivery | 1.75 | 0.45 | 3.9 | <0.001 |
| Cesarean section | -7.49 | 0.35 | -21.6 | <0.001 |
| Maternal age at delivery | | | | 0.4 |
| <20 years | -1.88 | 1.35 | -1.4 | 0.2 |
| 20–24 years | -0.11 | 0.46 | -0.2 | 0.8 |
| 25–29 years | | | | |
| 30–34 years | -0.34 | 0.33 | -1.0 | 0.3 |
| 35≤ years | -0.59 | 0.39 | -1.5 | 0.1 |
| Residential area | | | | 0.7 |
| Coastal area | -0.15 | 0.33 | -0.5 | |
| Other area | | | | |
| Infant sex | | | | <0.001 |
| Male | | | | |
| Female | 0.99 | 0.27 | 3.7 | |
| Parity | | | | <0.001 |
| First birth | | | | |
| Second or more | -1.59 | 0.31 | -5.1 | |

[†] p-value was calculated using t- and F-tests

Table 3 Adjusted gestational duration (days) after the Great East Japan Earthquake based on the final multiple linear regression model

| | Adjusted gestational duration (days) [†] | p-value [‡] |
|--|--|----------------------|
| Prenatal checkup institution | | |
| Only one institution | 274.9 | |
| Changed institution for personal reason | 274.6 | 0.8 |
| Went to parents' home for childbirth | 276.2 | 0.7 |
| Changed institution for medical indication | 264.3 | <0.001 |

[†]Adjusted for prenatal checkup institution, gestational period as of March 11, 2011, prenatal checkup schedule, mode of delivery, maternal age at delivery, residential area, infant sex, and parity and calculated with least square (LS) mean adjustment

[‡]p-value was calculated using the Dunnett's test with LS mean adjustment

Table 4 Adjusted odds ratio and 95% confidence interval for maternal and infant factors affecting preterm birth after the Great East Japan Earthquake (n = 5,256)

| Variables | Non-preterm birth | Preterm birth | Number of participants | p-value | Crude odds ratio | 95% confidence interval | Adjusted odds ratio [†] | 95% confidence interval |
|---|-------------------|---------------|------------------------|---------|------------------|-------------------------|----------------------------------|-------------------------|
| Prenatal checkup institution | | | | <0.001 | | | | |
| Only one institution | 3728 | 128 | 3856 | | Ref | | Ref | |
| (%) | 96.7 | 3.3 | | | | | | |
| Changed institution caused by self-referral | 1119 | 41 | 1160 | | 1.1 | 0.7 1.5 | 1.1 | 0.7 1.6 |
| (%) | 96.5 | 3.5 | | | | | | |
| Went to parents' home for childbirth | 49 | 2 | 51 | | 1.2 | 0.3 4.9 | 1.0 | 0.2 4.3 |
| (%) | 96.1 | 3.9 | | | | | | |
| Changed institution caused by medical | 139 | 50 | 189 | | 10.5 | 7.3 15.1 | 8.5 | 5.8 12.5 |
| (%) | 73.5 | 26.5 | | | | | | |
| Gestational period as of March 11, 2011 | | | | 0.9 | | | | |
| 4–11 weeks | 1243 | 54 | 1297 | | Ref | | Ref | |
| (%) | 95.8 | 4.2 | | | | | | |
| 12–19 weeks | 1265 | 51 | 1316 | | 0.9 | 0.6 1.4 | 1.0 | 0.7 1.5 |
| (%) | 96.1 | 3.9 | | | | | | |
| 20–27 weeks | 1298 | 60 | 1358 | | 1.1 | 0.7 1.5 | 1.0 | 0.7 1.5 |
| (%) | 95.6 | 4.4 | | | | | | |
| 28–36 weeks | 1229 | 56 | 1285 | | 1.0 | 0.7 1.5 | 1.0 | 0.7 1.5 |
| (%) | 95.6 | 4.4 | | | | | | |
| Prenatal checkup schedule | | | | 0.11 | | | | |
| On schedule | 3879 | 160 | 4039 | | Ref | | Ref | |
| (%) | 96.0 | 4.0 | | | | | | |
| Unscheduled | 1156 | 61 | 1217 | | 1.3 | 0.9 1.7 | 1.2 | 0.8 1.6 |
| (%) | 95 | 5 | | | | | | |
| Mode of delivery | | | | <0.001 | | | | |
| Normal vaginal delivery | 3543 | 103 | 3646 | | Ref | | Ref | |
| (%) | 97.2 | 2.8 | | | | | | |
| Instrumental vaginal delivery | 534 | 14 | 548 | | 0.9 | 0.5 1.6 | 0.9 | 0.5 1.6 |
| (%) | 97.4 | 2.6 | | | | | | |
| Cesarean section | 958 | 104 | 1062 | | 3.7 | 2.8 4.9 | 3.2 | 2.4 4.3 |
| (%) | 90.2 | 9.8 | | | | | | |
| Maternal age at delivery | | | | 0.4 | | | | |
| <20 years | 52 | 3 | 55 | | 1.7 | 0.5 5.5 | 1.7 | 0.5 6.0 |
| (%) | 94.5 | 5.5 | | | | | | |
| 20–24 years | 619 | 29 | 648 | | 1.4 | 0.9 2.1 | 1.2 | 0.8 2.0 |
| (%) | 95.5 | 4.5 | | | | | | |
| 25–29 years | 1585 | 55 | 1640 | | Ref | | Ref | |
| (%) | 96.6 | 3.4 | | | | | | |
| 30–34 years | 1750 | 85 | 1835 | | 1.4 | 0.99 2.0 | 1.4 | 1.0 2.0 |
| (%) | 95.4 | 4.6 | | | | | | |
| 35≤ years | 1029 | 49 | 1078 | | 1.4 | 0.9 2.0 | 1.1 | 0.7 1.6 |
| (%) | 95.5 | 4.5 | | | | | | |
| Residential area | | | | 0.9 | | | | |
| Coastal area | 1373 | 61 | 1434 | | 1.0 | 0.8 1.4 | 1.0 | 0.7 1.4 |
| (%) | 95.7 | 4.3 | | | | | | |
| Other area | 3662 | 160 | 3822 | | Ref | | Ref | |
| (%) | 95.8 | 4.2 | | | | | | |
| Infant sex | | | | 0.004 | | | | |
| Male | 2574 | 135 | 2709 | | Ref | | Ref | |
| (%) | 95.0 | 5.0 | | | | | | |
| Female | 2461 | 86 | 2547 | | 0.7 | 0.5 0.9 | 0.7 | 0.5 0.9 |
| (%) | 96.6 | 3.4 | | | | | | |
| Parity | | | | 0.9 | | | | |
| First birth | 1364 | 61 | 1425 | | Ref | | Ref | |
| (%) | 95.7 | 4.3 | | | | | | |
| Second or more | 3671 | 160 | 3831 | | 1.0 | 0.7 1.3 | 0.9 | 0.7 1.3 |
| (%) | 95.8 | 4.2 | | | | | | |

[†] Adjusted for maternal body mass index before pregnancy and maternal age at pregnancy